

Crawl Space Research

Managing moisture and saving energy with closed crawl spaces

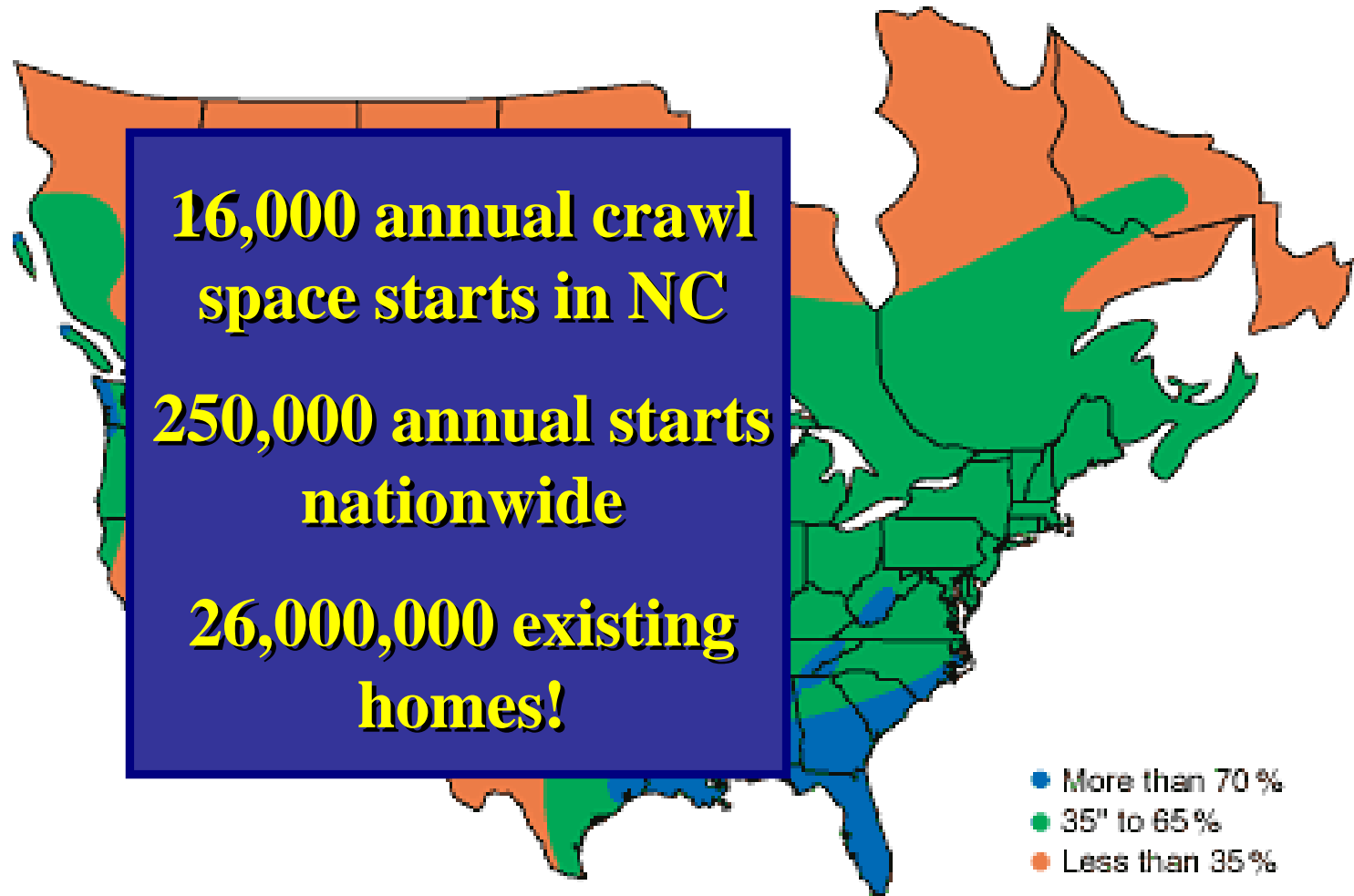
Cyrus Dastur



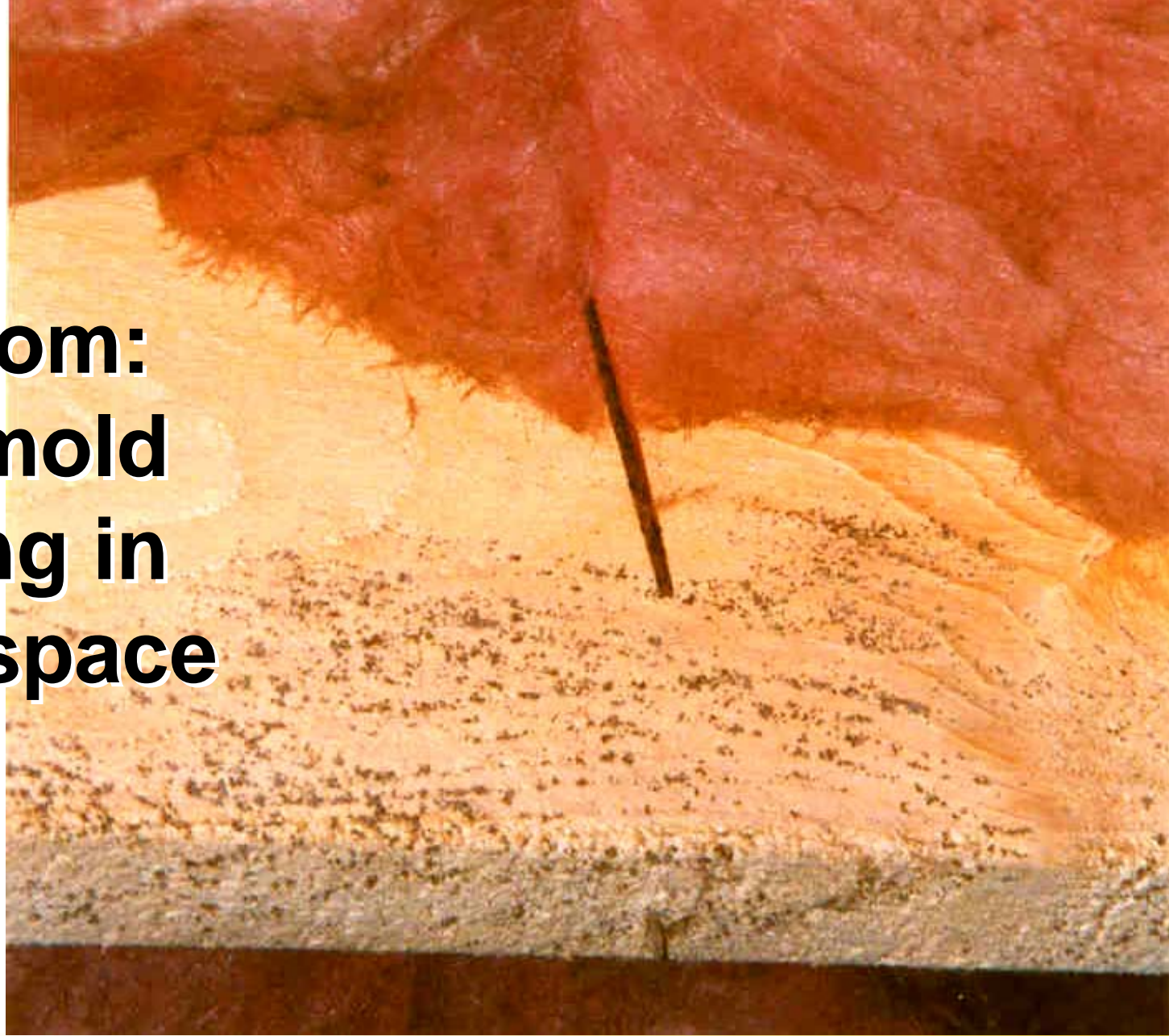
Crawl Space Moisture Problems



Chances for Above Ground Decay



**Symptom:
Light mold
spotting in
crawl space**



Typical response: Add ventilation





Resulting mold explosion

**Some lumber
still good**



A red Swiss Army knife is shown stuck into a piece of wood. The knife is oriented vertically, with the handle at the top and the blade pointing downwards. The wood is light brown and shows signs of decay or rot, particularly in the area where the knife is inserted. A small, dark, irregular piece of wood has just been removed from the wood's surface by the tip of the knife, illustrating the concept of rot.

**Some
lumber
rotten**

Data was Needed to Understand the Problems and Solutions



Funding

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Co-Funding and Project Management

Advanced Energy

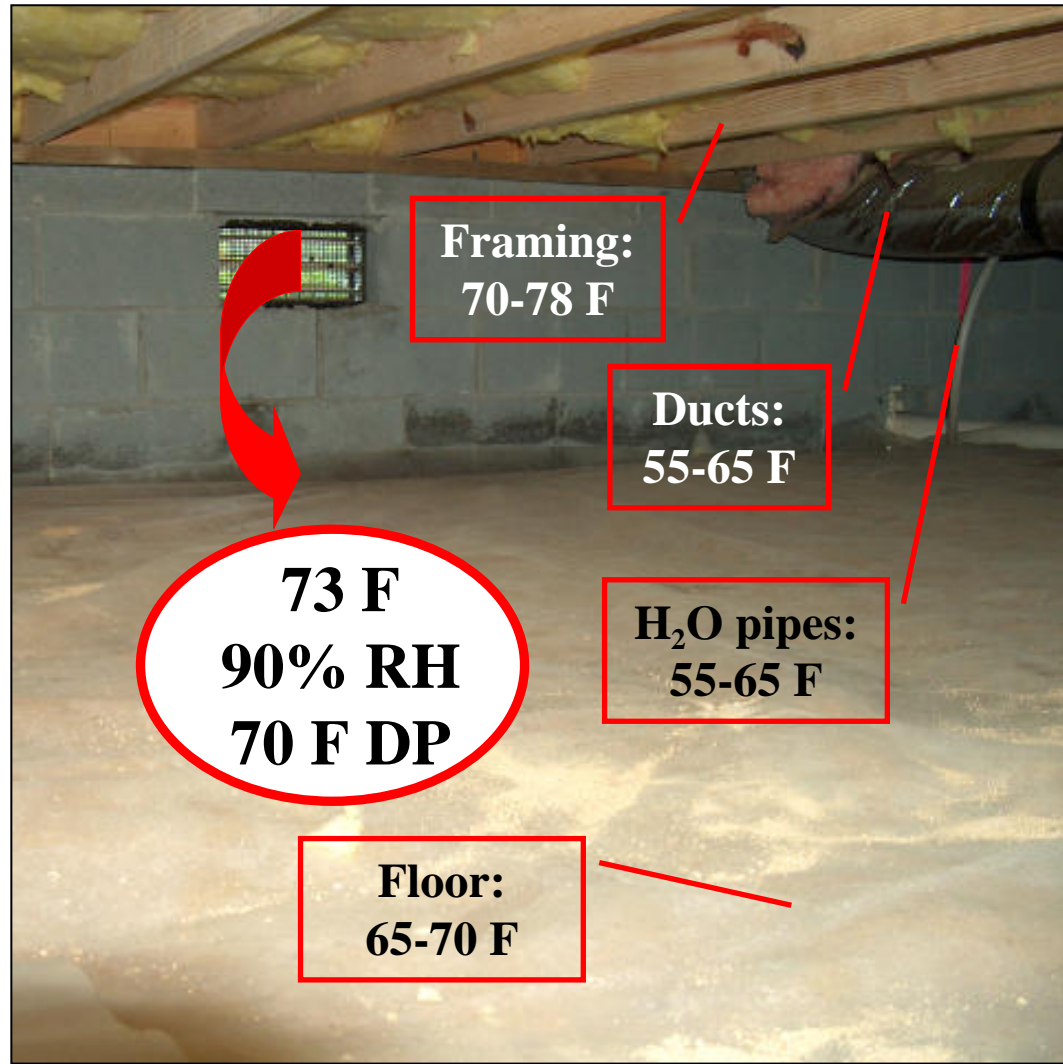
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Project Goals

- **Research:** Monitor and compare the thermal and moisture performance of closed vs. wall-vented crawl spaces
 - 12-Home Field Study
 - 2-Home ORNL Hygrothermal Study
- **Technology Transfer:** Accelerate acceptance of properly closed crawl space systems

Why add ventilation to a crawl space???



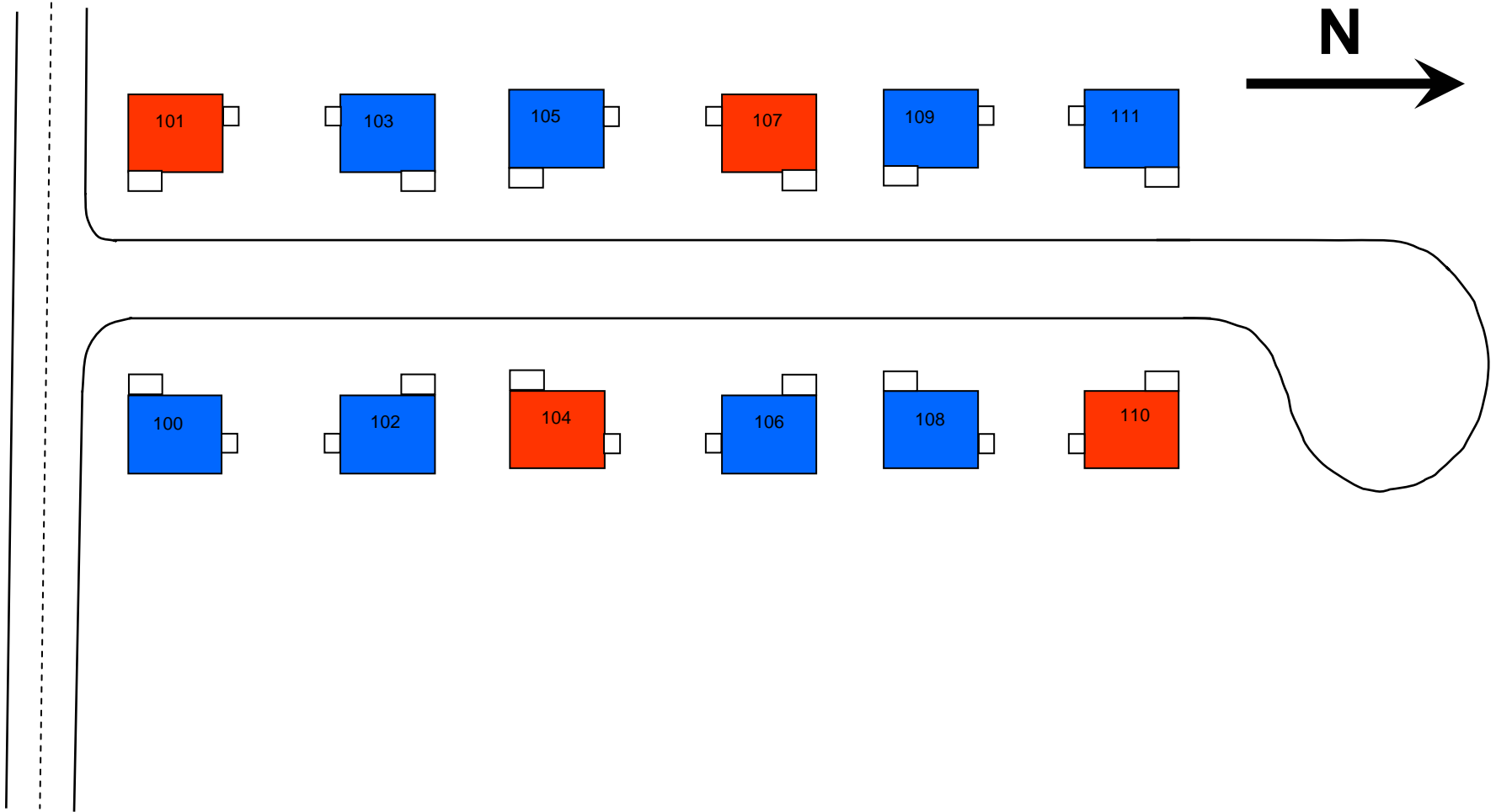
Site Elevated for Flood Protection



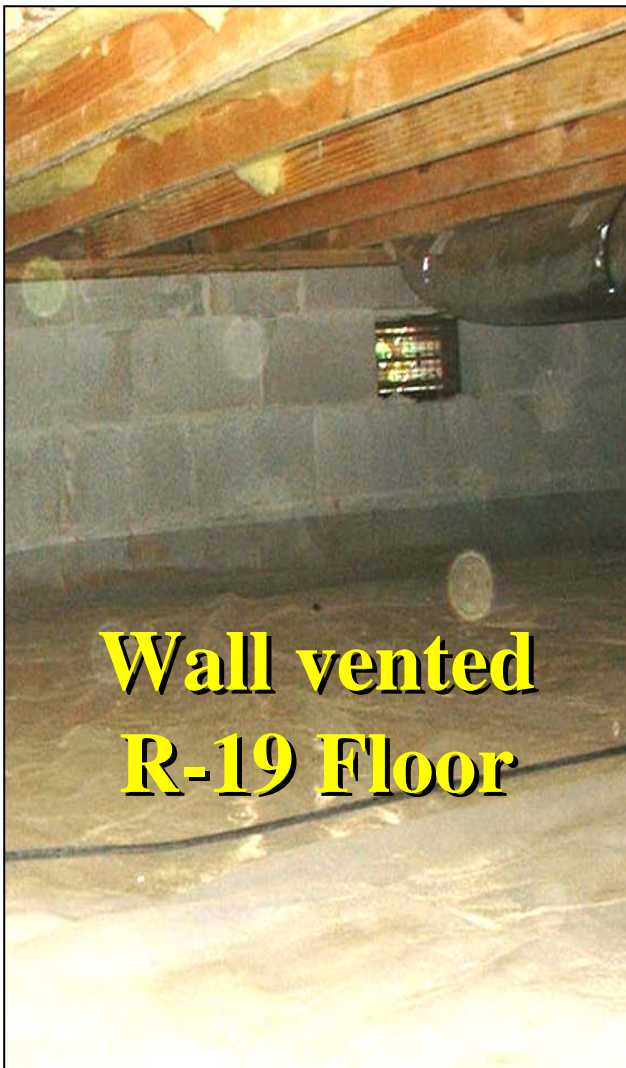
Homes Complete and Occupied



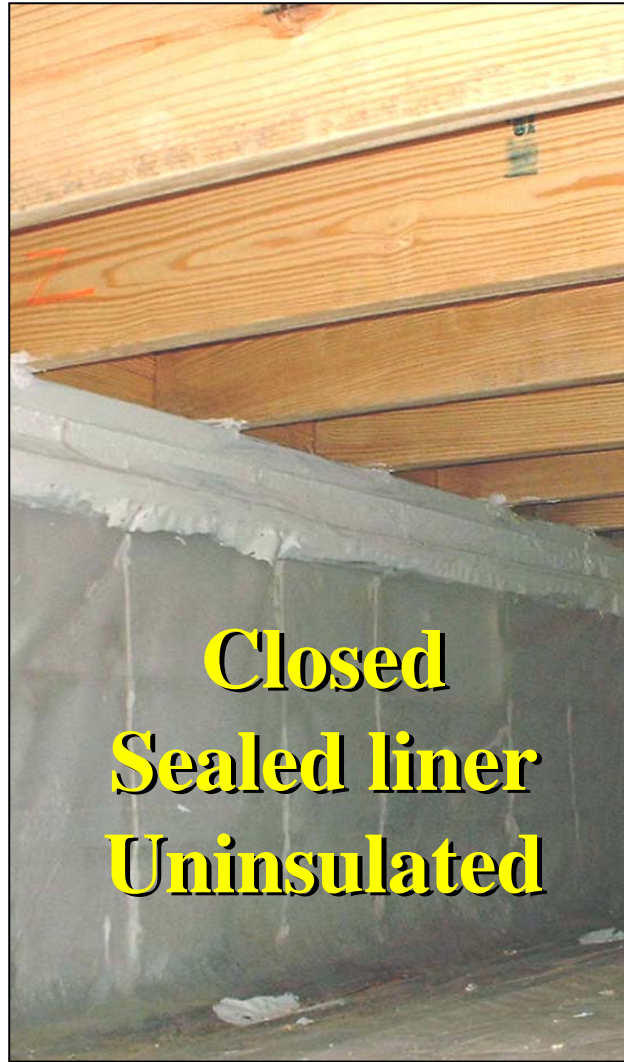
12 Home Field Study Site



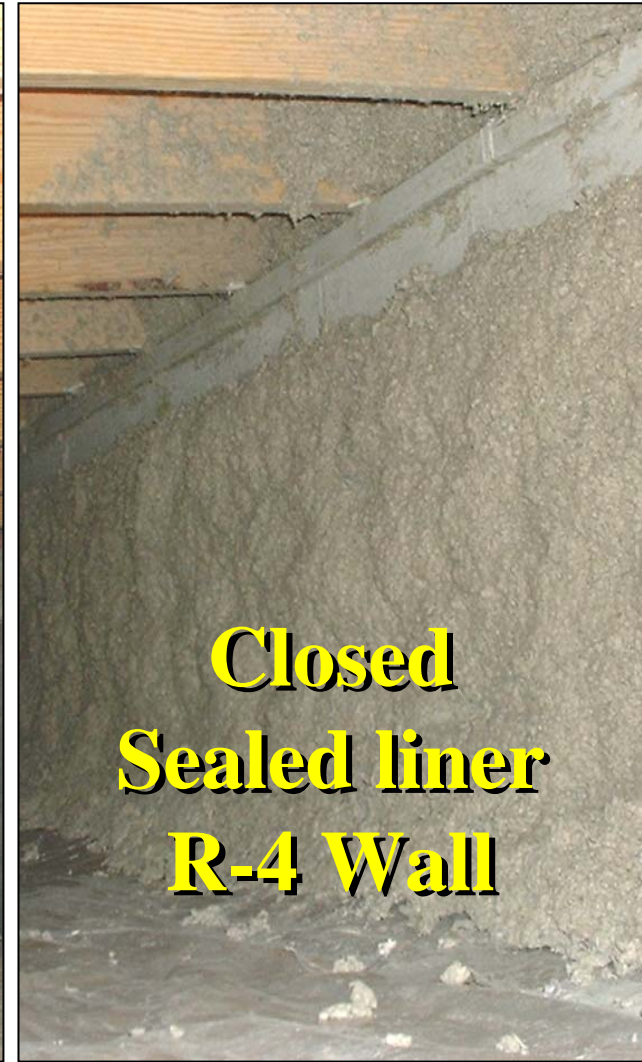
Phase I: July 2001 – May 2003



**Wall vented
R-19 Floor**



**Closed
Sealed liner
Uninsulated**

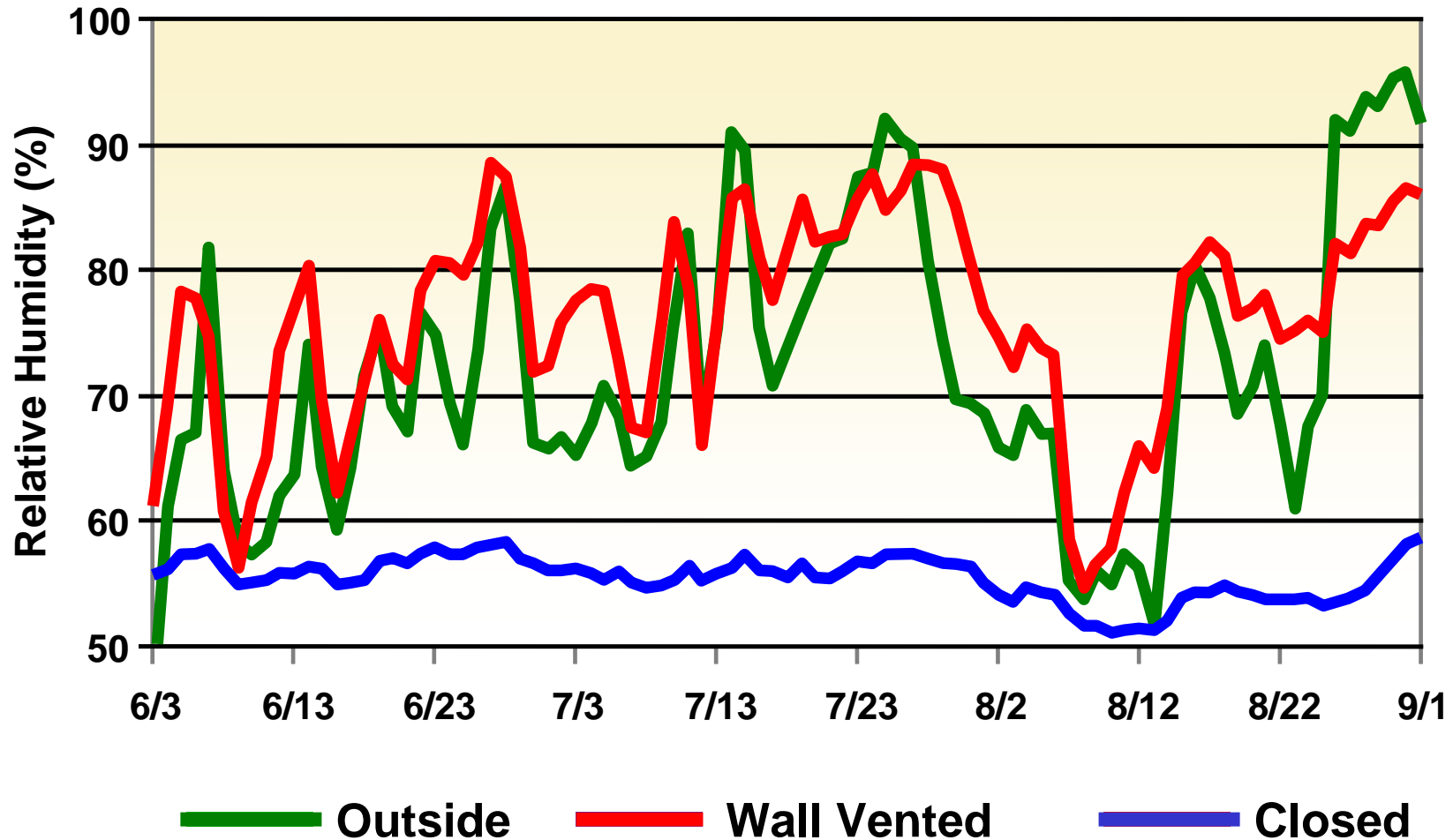


**Closed
Sealed liner
R-4 Wall**

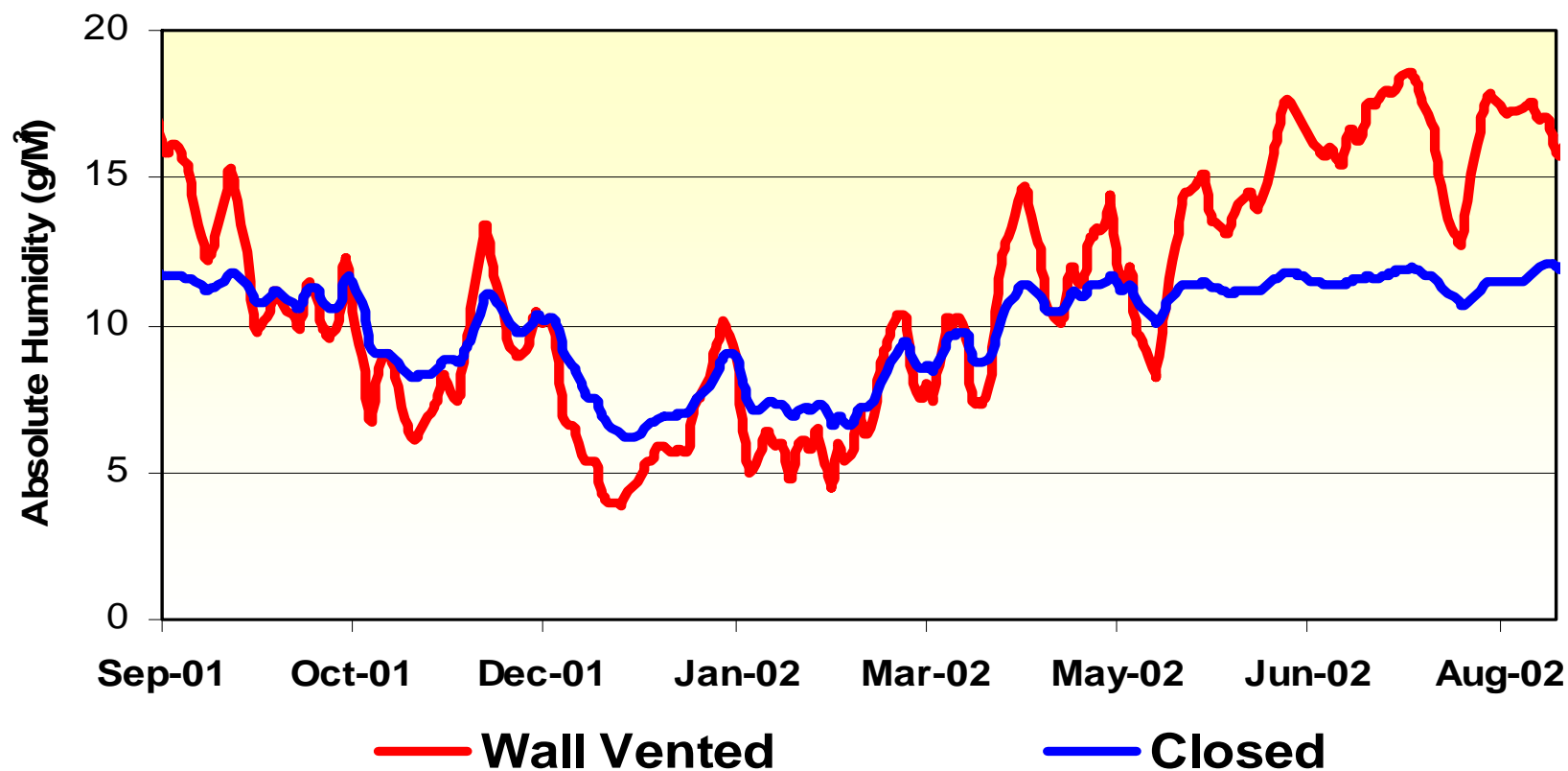
Data Collection & Monitoring

- Component air leakage testing
- Temperature and RH logging
- Pin wood moisture readings
- Bio-aerosol sampling
- Short- and long-term radon monitoring

Phase I Crawl Space Relative Humidity



Phase I Crawl Space Absolute Humidity



Phase I Results

- **Humidity was controlled in closed crawl spaces and not controlled in wall-vented crawl spaces**
- **Utility bill analysis indicated that the closed crawl space houses might be saving energy on heating and cooling (even with 4 uninsulated homes!).**

New Phase Begins in June 2003

- Sub-metered all heat pumps
- Air-sealed all floors and crawl space ductwork
- Re-measured component leakage
- Provided HVAC supply air in closed crawls
(1 cfm per 30 square feet)
- Modified closed crawl space insulation systems

Phase II: June 2003 – June 2004



**Wall vented
R-19 Floor**

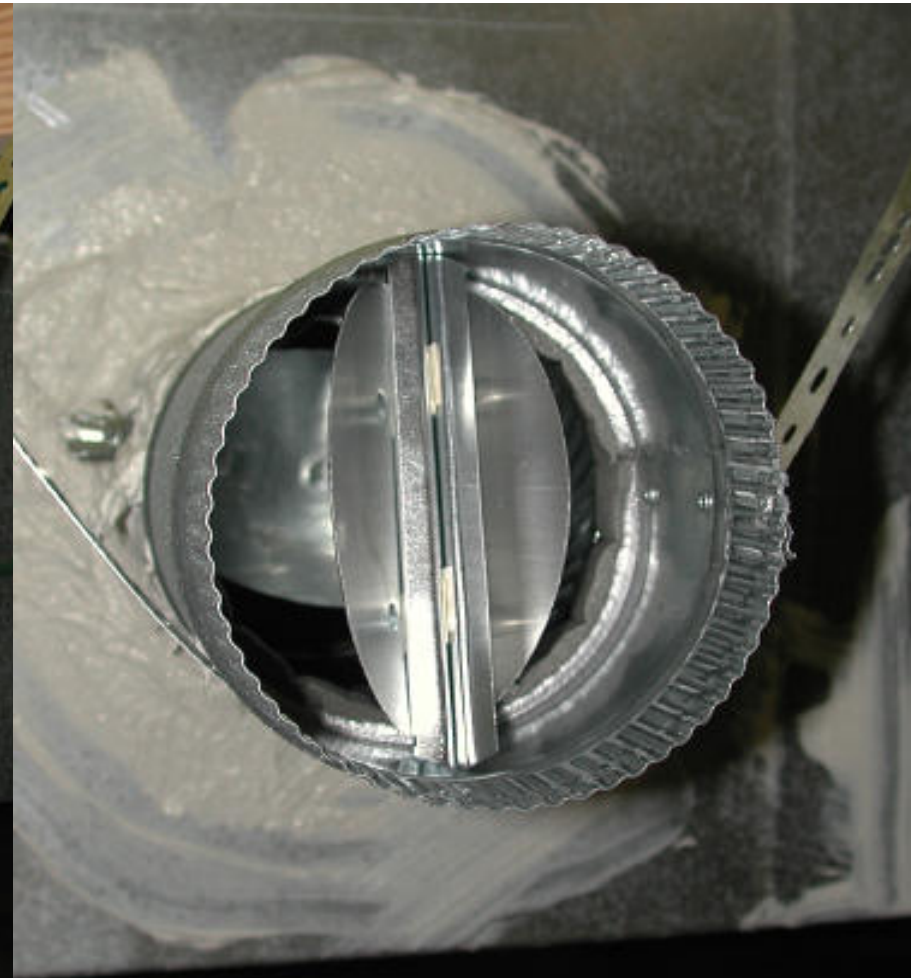


**Closed
Sealed liner
R-19 Floor**

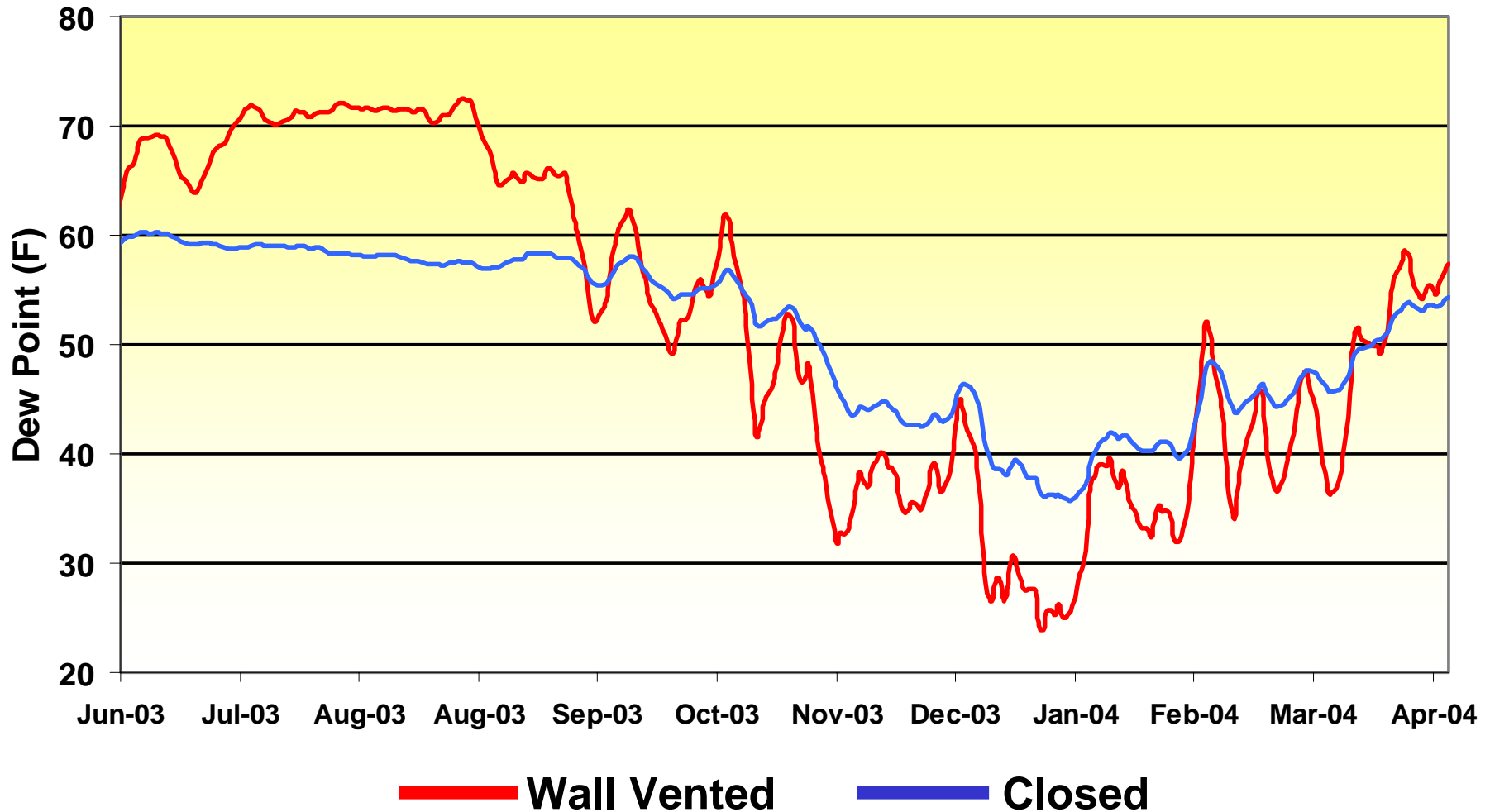


**Closed
Sealed liner
R-13 Wall**

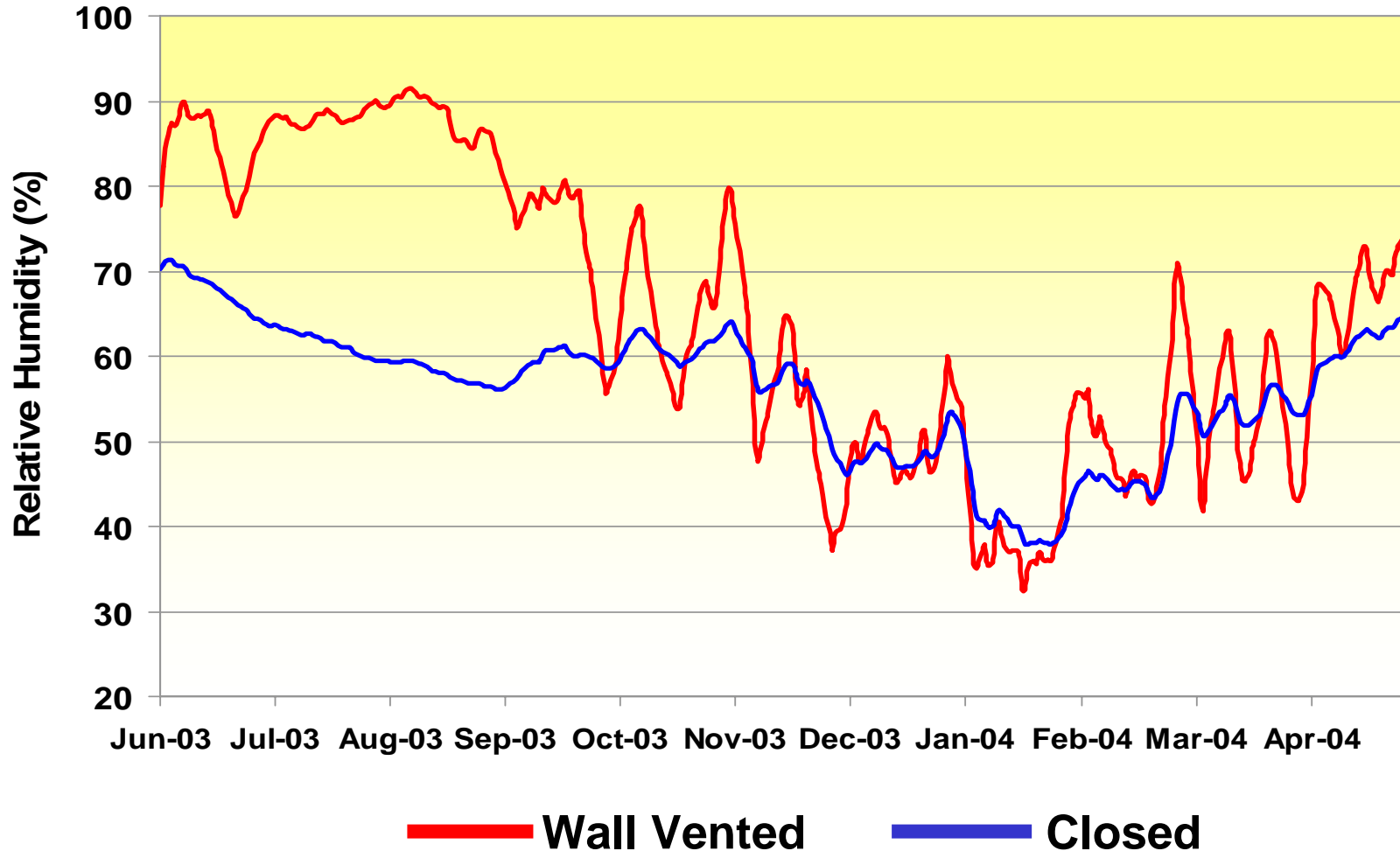
Crawl Space Supply Air Duct



Phase II Crawl Space Dew Points



Phase II Crawl Space Relative Humidity

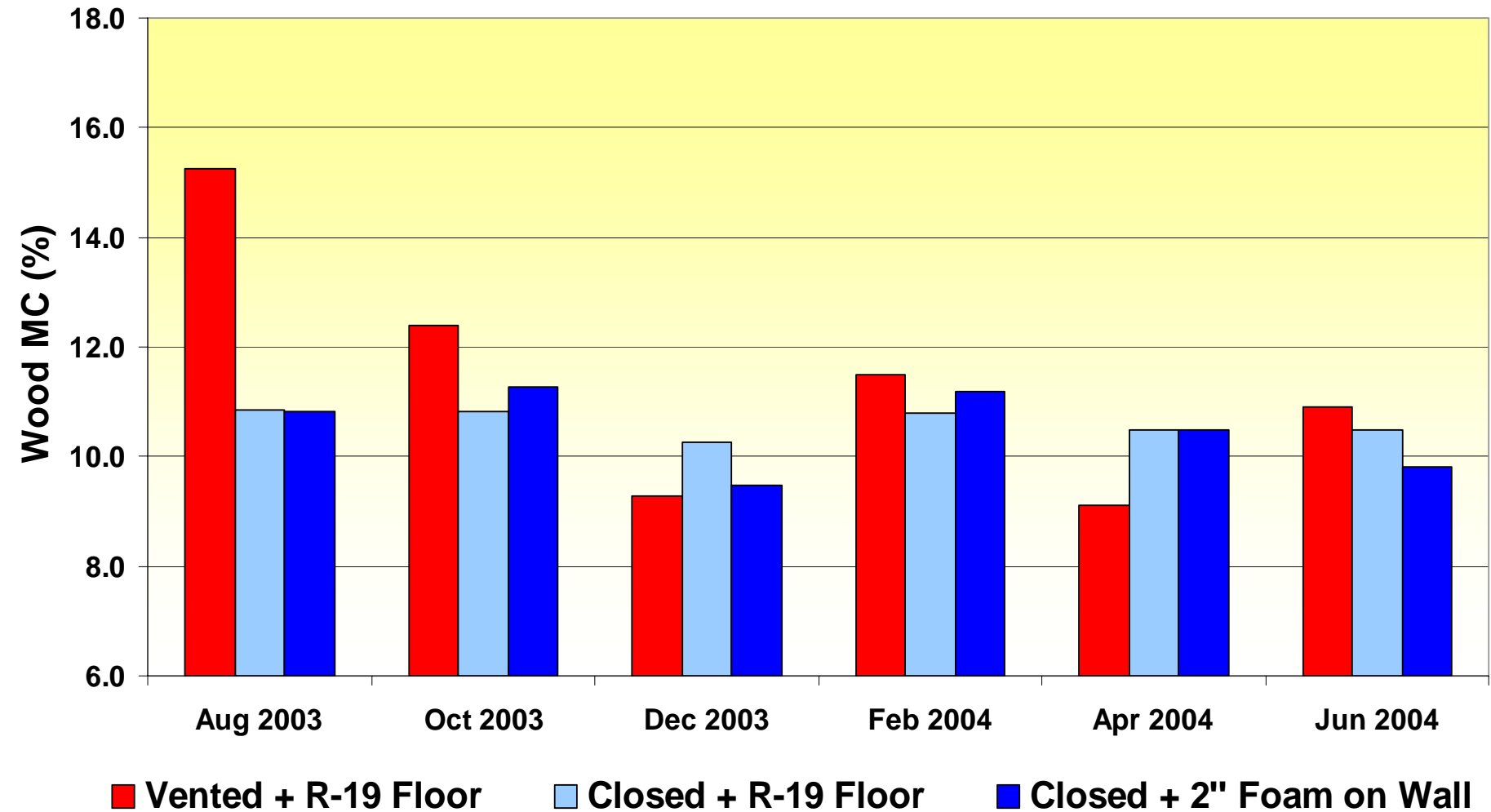


Summer RH Summary

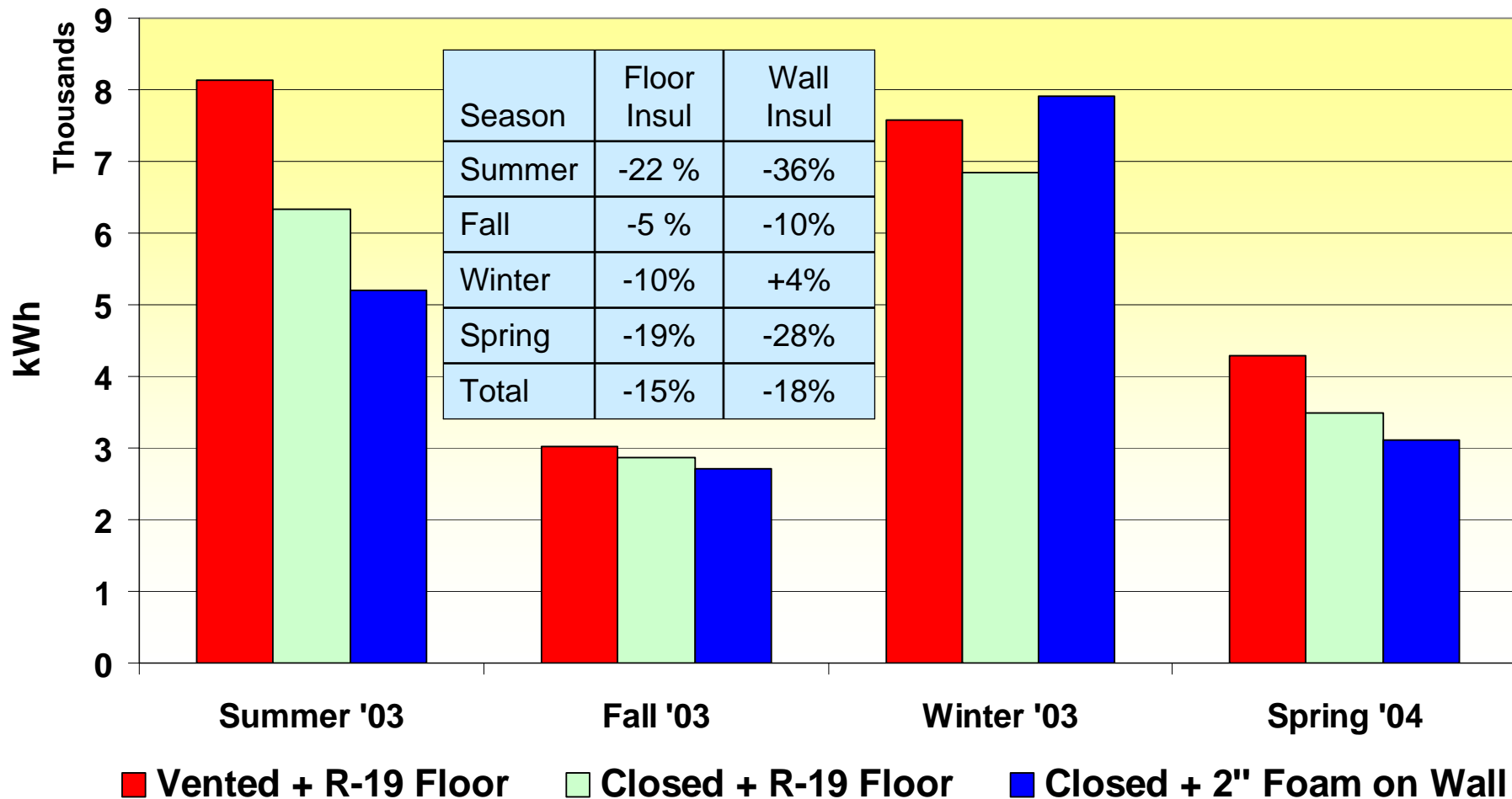
(Summer: June - August)

<u>Percentage of Time</u>	<u>2002</u>		<u>2003</u>	
	<u>Vented</u>	<u>Closed</u>	<u>Vented</u>	<u>Closed</u>
Above 90% RH	0%	0%	23%	0%
Above 80% RH	39%	0%	86%	0%
Above 70% RH	79%	0%	98%	5%
Above 60% RH	94%	0%	100%	64%
Above 50% RH	100%	100%	100%	100%

Phase II Average Wood Moisture Content



Seasonal Total Energy Use

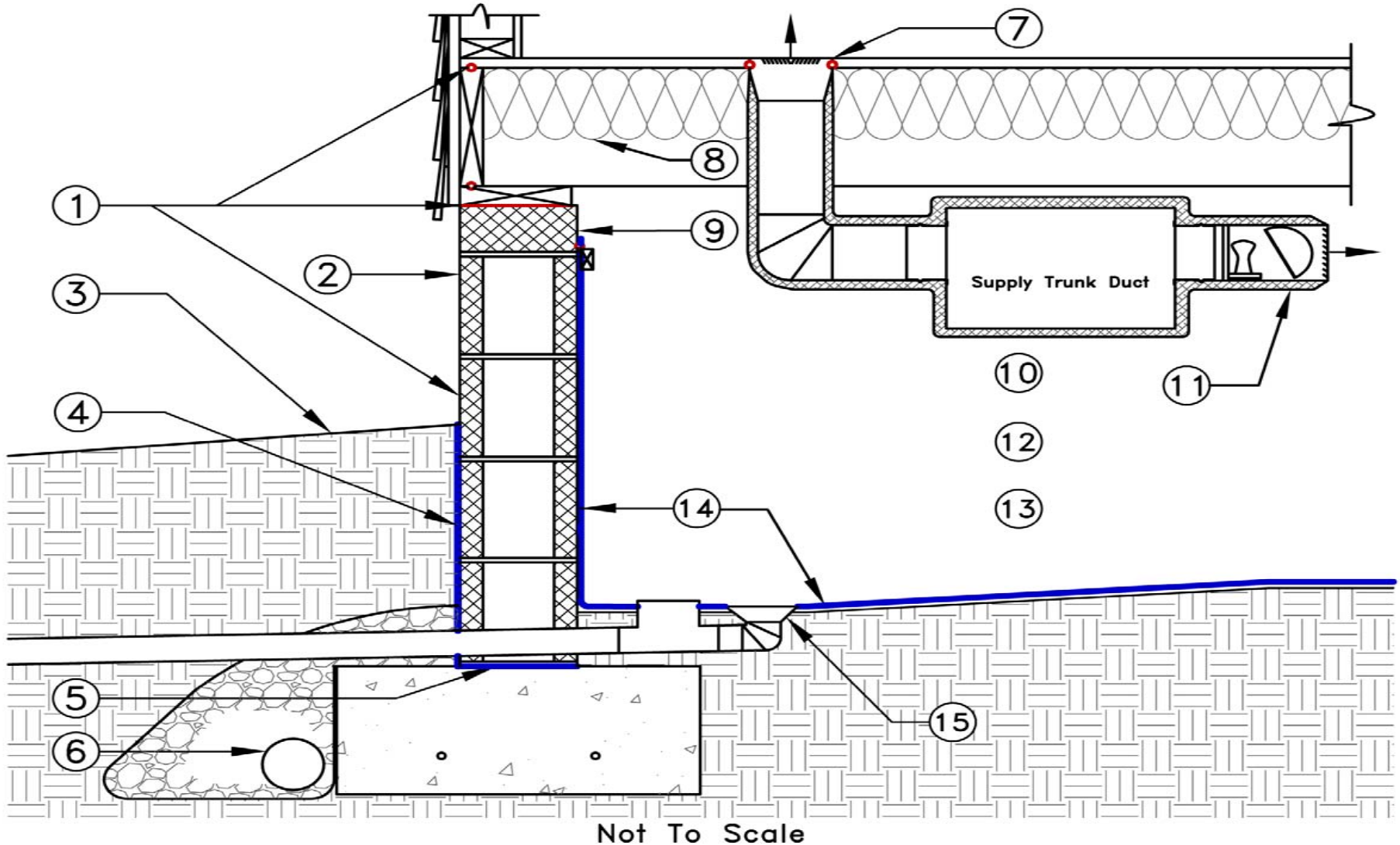


Next Steps: Technology Transfer

*Implementing practical changes for large
moisture and energy benefits*

- Closed crawl space construction guides
- Fact sheets and research results
- Design and analysis tools
- Code language

Next Steps: Construction Guides



Next steps: Future research

- Extend energy and moisture research to new regions and house geometries
- Test and measure new drying methods
- Test new component products
- HUD study: Is there a health connection?
- Duke study: Vented crawl spaces as sources of indoor air contaminants

Next Steps: Product Development

- Structural support
- Air leakage retarder
- Capillary retarder
- Vapor retarder
- Pest management solution
- Thermal insulation
- Fire protection

Six Implementation Issues

- Overcoming “physics- and logic-free zones”
- Applying codes; working with code officials
- Choosing a design
- Pricing closed crawl space work
- Managing labor: safety, skills, pay
- Managing moisture and job-site logistics

Six Design Issues

- Pest control
- Moisture control
- Fire standards
- Thermal standards
- Combustion safety
- Radon control

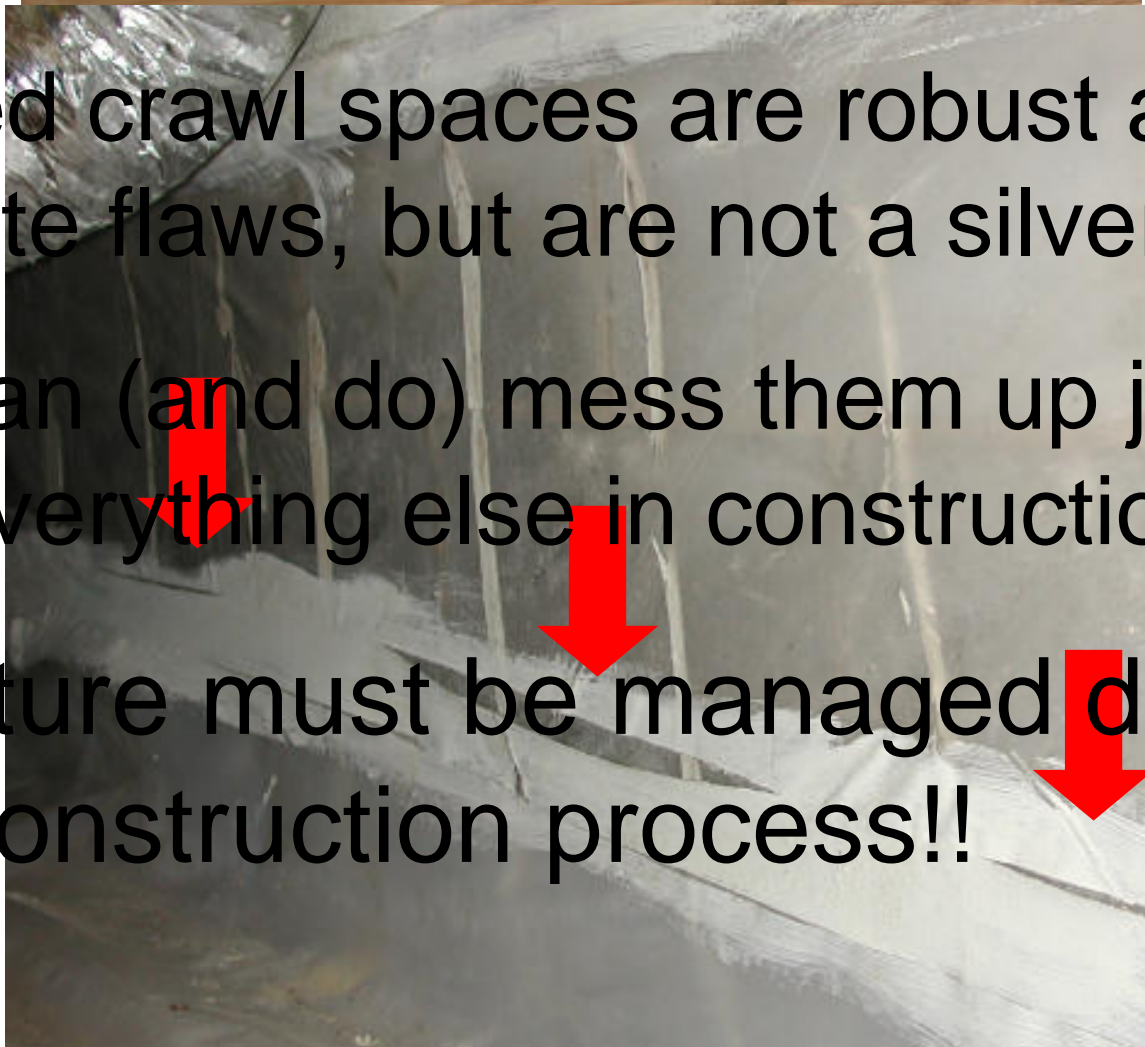
Provide combustion air!

Tjernlund.com

Fieldcontrols.com

Proceed with Care!

- Closed crawl spaces are robust and tolerate flaws, but are not a silver bullet
- We can (and do) mess them up just like everything else in construction
- Moisture must be managed during the construction process!!



Thank You!

Advanced Energy

Raleigh, NC

www.advancedenergy.org

www.crawlspaces.org